tities of Ipomœa pandurata were found with all parts distorted almost out of recognition with galls in which the oöspores made up the greater part of the swollen masses.

Mycologists and others are welcome to specimens of the various species mentioned in these notes.

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Notes on the flora of the Lake Superior region. IV.

E. J. HILL.

At Tower I found my first specimen of Geum macrophyllum. It is by no means common in our region. Wheeler and Smith say of it for Michigan: "Rare or not at all in the Lower Peninsula." Upham states that it is abundant north of Lake Superior, where Agassiz also gives it in his work on Lake Superior. It has been found by Dr. Vasey in northern Illinois.

Pretty forms of Circæa alpina were seen in its characteristic localities. The flowers were tinged with red. The pedicels of the flowers and the rachis of the raceme were thickly covered with glandular hairs. Reddish flowers are known to occur in this species, and it seems to approach in this respect its congener, C. Lutetiana.

In the wet grassy grounds, and open grassy woods, was obtained a somewhat unusual form of Campanula aparinoides. It first attracted attention by the color of the flowers and their large size for the species. All were bluish-white, changing to a decided blue on drying. Plants seen about Chicago are nearly always white, though some are tinged or faintly striped with blue, and also become more deeply colored as they dry. The corolla of the Minnesota specimens was from three to four times the length of the calyx lobes. The stems were of ordinary height, but freely branched in a paniculate manner. Nor are the stems of the plants found in this vicinity simple, as they are described in many of our books; they are really branched, and bear a single flower at the end of each leafy branch that is from two to six inches long. This ends in a slender peduncle, but it is provided with leaves like those of the main stem, diminishing in size as the flower is approached. But the branches do not often divide, and the stem is racemosely branched. Wood is more accurate in the description of the plants as I find them, since he characterizes the stems as "branched above." In the

specimens from Minnesota the ultimate branches bear terminal flowers, as is the case with those found here. The base of the corolla, as well as that of the filament, is copiously supplied with long hairs, somewhat reflexed in the Minnesota plants, though they are commonly horizontal. I do not find these hairs mentioned in our descriptive botanies, nor in the Synoptical Flora, although they do mention the hairy style and its adaptation to the collection of pollen. Mention is also made of the dilated bases of the filaments. Yet the hairs are a noteworthy feature and have been frequently referred to, especially in connection with the structure of the flowers for cross fertilization. They project from the margins of filaments, interlocking and closing the free spaces remaining between the bases of the filaments, or "triangular valves," as they are called by Sprengel and Hermann Müller. This is rather from their shape in C. rotundifolia and other European species, for in C. aparinoides they can hardly be called triangular, but only a little dilated. They were called scales by Linnæus[1] or his pupil, Hall, and were mistaken for nectaries, surrounding the base of the style, each bearing a filament at its top.

In the clearings and newly cultivated fields Physalis grandiflora attracts the eye with its large flowers of the purest white. They sometimes measured more than two inches across. The corolla is shallow, saucer-shaped, its border nearly entire. It is a plant worthy of cultivation as an annual, though it has one disadvantage, the flowers not being so prominent as their large size would suggest, being somewhat obscured by the large overshadowing leaves.

Spiranthes gracilis was frequent on some of the moist hillsides, partly covered with shrubs and seedling trees, in the partial shade of which it grew. It had one peculiarity a little singular to my experience with the plant in flower, since nearly all the plants had a tuft of fresh radical leaves, five or six in number. As generally found, it is necessary to look over several individuals to find an occasional specimen with a radical leaf or two in this condition at the time of flowering. I once met with it in this state of growth near Whiting, Ind., but the leaves were not so many, though nearly every plant bore some which were fresh.

Several kinds of Potamogeton were obtained in Vermilion Lake and its affluents. In the lake P. perfoliatus, var. lanceolatus, was one of the most common. P. pectinatus was seen

[1]The Nectaries of Flowers, Fundamenta botanica, Tome I, p. 276.

less frequently. *P. heterophyllus* Schreb., or what seems to be that, the plant being of very large size, was plentiful in some places, evidently the *P. gramineus* Fries., var. *maximus* Morong, found there also by the botanists of the Minnesota Survey in 1886. There are characters which ally it to P. Zizii, and it appears to be intermediate in its characteristics. It approaches in size P. lucens, the stem often being five or six feet long when the water is deep. They are also very branching above, and with leaves exceedingly numerous. They are all very large for P. heterophyllus, except some of the floating ones, which are also large in some specimens, and with long slender petioles when floating. The submerged leaves are rather thin in texture, tapering below, as is usual in the species, the uppermost lacking the coriaceous and shining look of those usually found on stems of P. Zizii and sometimes P. lucens. The fruit is also uncommonly large and when mature more rugose than in P. heterophyllus, which is generally smooth. It is also more inclined to have a keel, as in P. lucens. The fruiting spikes are an inch and a half to two inches long, the ripened fruit somewhat scattered. In typical P. heterophyllus the spikes are commonly about an inch long, cylindrical and densely fruited, while in P. Zizii and P. lucens they are more as in these specimens, long and with fruits more lax. The var. maximus not being recognized even as a synonym in the Revised Manual, there is some doubt where to place these plants, since they are at quite a remove from the typical species, and so marked as to deserve some distinction. I have nowhere seen such large specimens of this species, though finding some with long slender stems, with few leaves, in the small lakes in western New York. The var. graminifolia often has an elongated stem, but not branching as in this case. They also show that there are links, quite closely connecting P. heterophyllus and P. Zizii, and not very remotely P. lucens, though placed in a different section. This is also apparent by the shifting of P. gramineus, var. (?) spathulæformis, over to P. Zizii, and the making of *P. lucens*, var. *minor* Nolte, a synonym of the same species. And I have also found in the shallow ponds of this vicinity P. lucens with green emersed leaves, a condition that may to some degree be accidental by the lessening of the depth of water where they grow in the drier seasons, though proximity to Lake Michigan prevents it falling beyond a certain stage, the water being maintained at the level of the lake by seeping through the sand, or even rising and falling with the winds as they drive the waves to

or from the shores. In such cases the uppermost leaves are green and rest upon the water, the immersed ones shining, all usually coriaceous and with short petioles.

P. pusillus was detected in pools, and in East Two Rivers the related species *P. mucronatus* Schrad. P. Pennsylvanicus was common, some specimens of which, taken from West Two Rivers, had the immersed leaves 7-nerved, the 5-nerved being the usual kind. In the same stream P. rufescens was frequent, and the species rather rare at the west, *P. obtusifolius* Mert. & Koch. It was the first time I had met with it in its place of growth. The stems were quite robust, from two to three feet long; the leaves very uniform in length, or about three inches, acute or acutish, giving it the appearance of small-leaved forms of *P. zosteræfolius* Schum. It was fruiting abundantly, maturing from 12 to 22 nutlets in oblong capitate spikes, half an inch in length, on peduncles fully three times as long. These peduncles, long as compared with the length of the head, I have noticed in specimens from the east by exchange, and the descriptions err by limiting them to about the length of the head. This is as far west as it seems to have been reported in our limits, unless recently found, though found about as far north, in Gratiot Lake, Keeweenaw Peninsula. Prof. J. C. Arthur had previously found it, with most of those already mentioned, in the same locality as seen by his "Report on botanical work in Minnesota for the year 1886."[2]

Another aquatic is worthy of mention, a form of *Sagittaria variabilis* Engel., with floating leaves, found in the same stream. Prof. Arthur also collected it from this locality. It does not seem to be mentioned in the text-books, or in the botanical works of Engelmann, though he gives a variety fluitans for S. heterophylla and S. calycina. In appearance it is considerably different from the common kind, but hardly varies from the type except in this respect: the anthers are about the length of the filaments, rather broadly oblong; bracts 3 to 4; lower whorls of flowers sometimes diœcious; leaves sagittate, resting on the water, the round, slender petioles too weak to stand erect when removed from the water, to whose depth they correspond in length, those at Tower being from $2\frac{1}{2}$ to 3 feet. The scapes are also slender, but support the flowers and fruit above the water. I have occasionally seen it in other places, as about Chicago, but not in flower or fruit. It was not uncommon in the stream. It may deserve the varietal distinction fluitans, unless it has had

[2] Geological and Natural History Survey of Minnesota, Bulletin No. 3, St. Paul, 1887.

some other designation, for I have met with it often enough to look upon it as constant.

There was one feature of the flowers of this region deserving recognition, as it especially attracted my attention. It was the brightness of their coloration in hues belonging to the red and blue series. This was not noticeable in the yellow series, though it may have been because the shades of yellow are not so varied or striking. There was also a tendency in white flowers to become pink, or show some tinge of color, of which examples have been given. The familiar reds, pinks and purples of the flowers at home were more deeply shaded, and so of the blues and violets, or any intermediate hues. Though inclined to ascribe this to a northerly latitude, since it is known to be the case with plants in mountain regions and high latitudes in Europe, as in the Swiss Alps and Scandinavian Peninsula, it may not be safe to do this from the experience of a single season or the observations of a few days. It did not attract attention in the plants of the Saguenay observed the year before, nor was it noticeable along the south shore of Lake Superior. But the Saguenay country is rather rainy or foggy, and differs in this respect from the drier air and brighter sunlight of Minnesota, with sufficient moisture to keep plants in healthy conditions of growth, but under clearer skies. And I have experienced more of cloudy weather along the southern shore of Lake Superior, though essentially in the same latitude; and there is apparently more moisture in the air and a lessened brightness of the sunlight, the winds from the lake, as they come across it, bringing with them clouds if not rain.

Experiments and observations in regard to the coloration of flowers and the causes of their variability have led to somewhat varied or even contradictory conclusions, but they may throw some light on what was observed in this case. Hildebrand has considered the question in a treatise on the colors of flowers.[3] As direct causes of the formation of different colors, climatic relations, or the influence of light and temperature, are mainly considered. And it is these relations as they bear on the formation of colors other than green which form the subject matter. From the observations and experiments of Sachs and Askenasy the influence of light in the formation of these colors was seen to be very variable, with

[3] Die Farben der Blüten in ihren jetzigen Variation und früheren Entwickelung, von Dr. Friedrich Hildebrand, Leipzig, 1879. The conclusions as they relate to our subject are mainly embodied in pp. 47-57, where experiments of Sachs and Askenasy are discussed, and from which the references to their investigations are chiefly taken.

the exception of yellow, which was constant under the different conditions of experimentation. The experiments were more with plants in the contrasted conditions of light and darkness than in different degrees of intensity of light, though the latter was also considered. Sachs concluded that when other conditions of growth are normal, light has little to do with the formation of the colors of flowers. He says: "As long as sufficient quantities of assimilated materials have been previously accumulated, or are produced by green leaves exposed to light, flowers are developed even in continuous deep darkness which are of normal size, form and color.[4] Hildebrand remarks to the same effect, that the influence of light is intimately associated with the nourishment of the flower by stored up food, as seen in the case of bulbous plants, and the experiments of Askenasy with flowers developed on branches severed from the parent stock, which were sometimes of normal color. "From these few examples," he continues, "we see that light exerts an exceedingly varied influence on the formation of the blue and red colors in different plants, but whether this influence would be shown in the same way under all conditions among similar plants must be held in doubt."[5] His final conclusion is that in order to develop definite colors plants are inherently disposed to receive this influence, some for the development of one color, others for another; some plants in one definite direction, others in another, while in still others the susceptibility to vary may lead them in one direction as well as another, its usefulness to the plant determining what line of color-variation will be taken and ultimately fixed.[6]

De Lanessan devotes some attention to this question in an article in Baillon's "Dictionaire de Botanique,"[7] referring to Askenasy as well as to others that light has a direct influence on the formation of colors in plants besides the green. The few cases which seem to disprove this, of normal colors produced in darkness, he thinks may be traced to other causes; that light may be present the moment they are formed, and that experiments to prove that colors may be developed in darkness should not be confined to a single generation, but should show that they are capable of transmission.[8] Under such conditions he is of the opinion that the colors would at length disappear. He agrees with the idea that it is the usefulness to the plant which determines their colors, although—

[4] Text-Book of Botany, p. 754. Lehrbuch der Botanik, p. 725.
[5] l. c. p. 51. [6] l. c. p. 52.
[7] Coloration et matières colorantes des plantes, l. c. II, 152.

citing Wallace in this connection—it may not be due to the intensity of the light and heat.

On the other hand we have the experiments of H. C. Sorby, summarized by Vines in his edition of Sach's Text-Book, which go to show that the intensity of light has an important bearing on the case. According to Sorby, "Exposure to a greater or less degree of light may produce a great quantitative as well as qualitative difference in the coloring matters."[9] And in regard to the experiments of Sachs, that flowers developed in darkness are colored in much the same way as those developed in the light, Vines remarks: "Askenasy has, however, found that this is by no means always the case, but that the coloration of flowers is in many cases much modified or even absent when the plants bearing them are kept in darkness. There are not at present sufficient data upon which to base an explanation of the diversity of behavior of flowers in this respect, but it appears to depend upon their particular hue. Sorby has observed that the red coloring matter of flowers (which is probably identical with erythrophyll) is formed in smaller quantity in relatively weak than in relatively strong light."[10]

These experiments of Askenasy, and to some extent of Sachs (here taken from Hildebrand's account of them), were to the effect that though in the flowers of Tulipa Gesneriana (a bulbous plant), the red color of the cell contents is formed just as well in entire darkness as in the light, a smaller amount of it was made in the flowers of Tropæolum majus, Cheiranthus Cheiri, Phaseolus multiflorus and Antirrhinum majus. And according to Askenasy almost no production of color at all occurred in the dark in the flowers of Silene pendula; and in the flowers of Orchis ustulata he found that the lower lip had its ordinary color, while the upper lip was pure white, and sometimes the entire flowers. Other flowers showed a paler color under a less degree of light. Hildebrand also mentions what is so often evident, especially in the case of fruits exposed to the sun, that the red color is formed more on one side than on the other. He continues, "So we find that many plants of the plain, if they ascend to where they receive a brighter illumination, which is found on mountains, are colored red, as for example Achillæa Millefolium,

[8] Since light is necessary for the discernment of colors, the celerity with which it acts chemically in some cases may introduce an element of doubt, that what is seen by means of light may have been effected in the dark, though the probabilities are that the colors were so produced.

[9] Text-Book of Botany, p. 767.

[10] Physiology of Plants, p. 267.

while others in this stronger light retain their pure white color."[11] And in a foot note in this connection he cites Hoffman as authority for a change of color in the flowers of valerian (Baldrien in German) from flesh color in Germany to dark-red in Norway.

It seems very probable, therefore, notwithstanding this diversity of views, that bright skies and a continued strong illumination, whether regional or seasonal, may have the influence which was marked enough to be observed in Minnesota, a conclusion reached before making special inquiry to see if it accorded with facts observed by others. And while the inquiry has not in every way proved satisfactory, there yet is left a strong residuum of belief that the cause originally assigned is not without a basis for its support. So, in the experiments it was seen that the yellow colors were but little affected by varied conditions of light, as was the case in the flowers of the Minnesota plants. The subject offers an inviting field of inquiry to those who may be located so as to observe the plants of the northwest in this respect for a sufficient time, and thus reach a more trustworthy conclusion based on a longer series of observations.

Englewood P. O., Chicago, Ill.

Notes on some phanerogams of Central Minnesota.

CONWAY MACMILLAN.

The following is a partial record of observations made during August, 1890, by the writer, who, in company with Mr. E. P. Sheldon, of the University of Minnesota, studied the flora about Gull lake, Cass Co., and in the immediate vicinity of Brainerd, Crow Wing Co., Minn.

Brasenia peltata Pursh.—This plant is occasionally found in the northern part of the state, extending southward to Minneapolis, but is always rare or local. It grows luxuriantly in Irving Chase lake, twelve miles west of Gull lake, and, in a dozen other small forest lakes of the immediate neighborhood, is the most prominent plant. Apparently it excludes from these waters the white water lily (Nymphæa odorata) and tends to drive out the common pond lily (Nuphar advena).

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[11] l. c. p. 50.